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(54) Title of the Invention: Pneumatic Tire

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(72) Inventor: Masayuki OHASHI 3-2-7-508 Ogawahigashi-cho, Kodaira-shi, Tokyo[, Japan]
(72) Inventor: Yasumi KAWAGUCHI 2-570-7 Chuo, Higashiyamato-shi, Tokyo[, Japan]
(71) Applicant: Bridgestone Corporation 1-10-1, Kyobashi, Chuo-ku, Tokyo[,Japan]
(74) Agent: Gyoshu SUGIMURA, Attorney; and 1 other person

Specifications

1. Title of the Invention Pneumatic tire
2. Scope of Patent Claims

1. A pneumatic tire, with regard to a pneumatic tire possessing a tread portion formed by multiple blocks or ribs that divide the contact surface through the cutting of main grooves into the contact surface, characterized by

the rubber composition at the peripheral portions of the blocks or ribs that differs with these central portions being placed with a thickness of 0.3~10 mm,

the dynamic modulus of elasticity(1) of the rubber composition of the central portion being 60~140 kgf/cm^2 and the dynamic modulus of elasticity(2) of the rubber composition of the peripheral portion being 110~190 kgf/cm^2 at room temperature, and

with the value of dynamic modulus of elasticity(2) minus the value of dynamic modulus of elasticity(1) being a value within the range of 10~90 kgf/cm^2.

2. Pneumatic tire of Claim 1 wherein the portion within a range of 3~20 mm from the edge of both shoulder portions of the above-mentioned tread is formed from the same rubber composition as the above-mentioned rubber composition that forms the peripheral portion of the block or rib.

3. Pneumatic tire of Claim 1 or Claim 2 wherein the rubber composition of the above-mentioned peripheral portion is placed only at the lateral surface of the circumferential direction of the block or rib.

4. Pneumatic tire of Claim 1 which is a pneumatic tire characterized by the rubber composition of the peripheral portion appearing from the position at least ½ the height of the initial depth of main groove and with the tread surface also covered by the rubber composition of that peripheral portion.

3. Detailed Explanation of the Invention

(Field(s) of Industrial Applications)

This invention is related to pneumatic tire in which the abrasion resistance and resistance to irregular abrasion are improved at the same time.

(Prior Art)

The tire tread portion that contacts the road surface is generally formed from one type of rubber. However, there are differences in the degree of abrasion exhibited due to the distribution of forces acting within the contact surface, the distribution of the tread block's motions and the distribution of the slip rate, and thus, the tire's lifespan, external appearance and the likes arising from the uneven abrasion of the tread's contact surface and the occurrence of the so-called irregular abrasion phenomenon are not preferred.

Previously, for this sort of irregular abrasion, for example, the method used was that of the method as in Patent Publication 1976-100504(S51-100504) where rubber with high resistance to abrasion is placed at the tread's shoulder portion, or the method as in Patent Publication 1978-80602(S53-80602) where rubber with a thickness corresponding to ¼ to 1/3 of the block width and possessing a higher resistance to abrasion than the tread rubber is placed at the periphery of the groove set up on the tread's contact surface.

(Issue(s) Solved by the Invention)

Based on these methods, certainly there were results in the improvements for the resistance to irregular abrasion. However, the lifespan of these tires is dependent on the rubber quality of the central portion of the tread with degraded abrasion resistance, and although the resistance to irregular abrasion was improved, the level of abrasion resistance was inadequate.

So, the purpose of this invention is to present a pneumatic tire with improved abrasion resistance and resistance to irregular abrasion at the same time, for which the improvements were previously unobtainable.

(Means of Solving the Issue(s))

In order to achieve the above-mentioned objectives, this invention's pneumatic tire, possessing a tread portion formed with multiple blocks or ribs by dividing the contact surface through cutting main grooves into the contact surface, is characterized by the placement of a rubber composition, with a thickness of 0.3~10 mm and which is different from these central portions, at the peripheral portion of the above-mentioned blocks or ribs, and where at room temperature, the dynamic modulus of elasticity E'(1) of the rubber composition of the central portion is 60~140 kgf/cm^2 and the dynamic modulus of elasticity E'(2) of the rubber composition of the peripheral portion is 110~190 kgf/cm^2 with the value of the above-mentioned E'(2) minus the value of the above-mentioned E'(1) being a value within the range of 10~90 kgf/cm^2.

In this invention, it is preferred that the rubber composition within 3~20 mm from the edges of both shoulder portions of the tread being the same as the rubber composition forming the peripheral portion of the blocks or ribs.

In addition, for this invention, it is also fine to place the rubber composition of the above-mentioned peripheral portion only at the lateral surface of the circumferential direction of the block or rib.

Furthermore, in this invention, with regard to the pneumatic tire, it is possible to make the rubber composition of the peripheral portion appear from a position at least ½ the height of the initial depth of main grooves and also to cover the tread surface with the rubber composition of the peripheral portion.

(Effects)

For the irregular abrasion that arises mainly at the edges such as that of the pneumatic tire's shoulder, rib and block, it is known that both the motion amount and slip rate are larger at the peripheral portion when compared with the contact surface, and it occurs due to the rapid development of abrasion. Therefore, in this invention, rubber with higher elasticity than central portion 2 is placed at peripheral portion 3 of block or rib 1 as the structure shown in Figures 1~3, and improvements in the resistance to irregular abrasion was designed by making the block or rib's motions and slip rate to be entirely uniform. In addition, for the rubber composition of central portion 2 which is important in abrasion resistance, if just the dynamic modulus of elasticity is set to be within the prescribed range, the other properties can be freely controlled and at the same time, it is

sufficiently possible to make adjustments that should increase abrasion resistance. In this way, it is possible to obtain a pneumatic tire with the abrasion resistance and resistance to irregular abrasion improved at the same time.

In this case, the thickness of the rubber composition of peripheral portion 3 is 0.3~10 mm with 0.5~5 mm being preferred. If it is less than 0.3 mm, no improvement is seen for the resistance to irregular abrasion, and on the other hand, if it exceeds 10 mm, the improvement of abrasion resistance becomes smaller.

For edge portion 5, due to similar reasons, it is necessary for rubber composition of peripheral portion 3 to enter within a range of 3~20 mm from edge 5 of both shoulder portions of the tread.

In addition, as shown in Figure 4, it is not necessary for block or rib 1 possessing the rubber composition of peripheral portion 3 to be found on the entire surface of the tread surface, and it is fine if it is placed at appropriate portions. Furthermore, it is also not necessary for thickness (Q) of the peripheral block to be entirely uniform, and it does not matter if differences exist depending on location as long as it is within the above-mentioned thickness range.

In this invention too, it is necessary for E'(1) of the rubber composition of the above-mentioned central portion at room temperature to be within the range of 60~140 kgf/cm^2 with 80~120 kgf/cm^2 being preferred. If E'(1) is smaller than 60 kgf/cm^2, the improvement result for abrasion resistance is not substantively adequate, and conversely, if it is larger than 140 kgf/cm^2, it is not appropriate from the aspect of exothermic ageing [J2E translator: probably "heat generation and ageing" but comma separator is missing in original Japanese]. It is also necessary for E'(2) of rubber composition of peripheral portion 3 at room temperature to be within the range of 110~190 kgf/cm^2 with 140~180 kgf/cm^2 being preferred. If E'(1) [J2E translator: E'(1) as in original Japanese] is smaller than 110 kgf/cm^2, uniform effects and adequate control of block motions are not obtainable, and on the other hand, if it exceeds 190 kgf/cm^2, it is inappropriate from the aspect of heat generation, ageing (cracks) or cut resistance. Furthermore, it is necessary for the difference of E' expressed by E'(2)-E'(1) to be within the range of 10~90 kgf/cm^2.with 20~60 kgf/cm^2 being preferred. If there is deviation from this range, the problem of not being able to adequately make the rubber motions of central portion 2 and peripheral portion 3 uniform as well as the problem of damage from the interface arise.

This invention's pneumatic tire, for example, is obtainable by forming central region 2 of block or rib 1 during green tire molding, forming peripheral region 3 of block or rib on the above-mentioned tread rubber, sheet-shaping the above-mentioned rubber and pasting, and after vulcanizing inside the mold, shaving so that the tread pattern surface turns into the prescribed 2-layer structure. Furthermore, as shown in Figure 5, there is no shaving of the tread pattern surface, and it is also fine for the surface to be covered by the rubber forming the peripheral portion of block or rib 1, and for the formation of a 2-layer structure with the rubber of the corresponding peripheral portion appearing from the position at least ½ the height of initial main groove depth of main groove 4. This is because it is rare for marked irregular abrasion to show up in the initial period of travel, and it can be said that the improvements to abrasion resistance and resistance to irregular abrasion are adequately attainable if a 2-layer structure is manifested with the remaining grooves being at least at the 1/2 position. In addition, when industrial productivity is considered, the chipping of tread surface is not a reality, and it can be said that a product with the surface covered by the rubber composition of peripheral portion 3 is more of a reality.

Furthermore, each rubber composition's E' was measured with short book-shaped samples under conditions of 50Hz vibration frequency, 1% dynamic distortion and 25°C using a spectrometer test machine made by Iwamoto Seisakusho Co., Ltd.

(Embodiment(s))

This invention is further explained in detail below by showing the embodiments.

The rubber compositions blended according to the blending ratios (weight portions) shown in Table 1 were matched to the combination of treads on size 10.00R2 pneumatic tires (refer to Figure 3) possessing 4 grooves on the tread's contact surface, and the trial-production tires of each type of structure were produced. The evaluations on abrasion resistance and resistance to irregular

abrasion were respectively made based on observations of the tread contact surface and remaining groove amounts after traveling for 40,000 kilometers.

Table 1

Rubber Type	A	B	C	D	E
Natural rubber	100	100	70	55	40
Butadiene rubber *1	–	–	30	–	–
Styrene-butadiene rubber *2	–	–	–	45	60
ISAF carbon black	45	50	55	50	55
Stearic acid	2	2	2	2	2
Anti-ageing agent *3	1.25	1.25	1.25	1.25	1.25
ZnO	3	3	3	3	3
Sulfur	1.3	1.5	1.5	1.0	1.1
Vulcanization accelerator (Nobs) *4	1.1	1.1	1.1	1.1	1.3
E' (kgf/cm^2)	50	80	120	150	200
Abrasion resistance *5	95	100	130	95	95

*1...Made by Japan Synthetic Rubber Co., Ltd, product name: BRO1
*2...Made by Japan Synthetic Rubber Co., Ltd, product name: SBR#1500
*3...Made by America's Monsanto Company, product name: Santoflex13
*4...N-oxydiethylenebenzothiazyl-2-sulfenamide
*5...Abrasion resistance was measured using the Lamboum abrasion test machine, and expressed by indexing the value for rubber type B as 100.

Embodiments 1~3, Comparisons 1~8

The rubber composition of the rib's central portion and peripheral portion were chosen based on the combination of the various types of rubber compositions shown in Table 2, and based on the structure shown in Figure 3, the abrasion resistance and resistance to irregular abrasion were evaluated for each of the trial-production pneumatic tire.

Furthermore, Comparisons 1, 4, and 6 are respectively treads of single rubber type B, C, or D. In addition, the rubber thickness of the peripheral portion is 5 mm for whichever one. The obtained results are shown together in Table 2 below.

Table 2

	Comparison 1	Comparison 2	Comparison 3	Embodiment 1	Embodiment 2	Comparison 4	Embodiment 3	Comparison 5	Comparison 6	Comparison 7	Comparison 8
Central portion rubber type E' (kgf/cm^2)	B (80)	A (50)	A (50)	B (80)	B (80)	C (120)	C (120)	C (120)	D (150)	D (150)	D (150)
Peripheral portion rubber type E' (kgf/cm^2)	B (80)	C (120)	D (150)	C (120)	D (150)	C (120)	D (150)	E (200)	D (150)	C (120)	E (200)
Peripheral portion E' – central portion E'	0	70	100	40	70	0	30	80	0	-30	50
Abrasion resistance index *1	100	93	92	105	103	123	119	115	95	97	95
Resistance to irregular abrasion	X	X	X	Δ	O	X	O	X	Δ	X	Δ

*1...Expressed by indexing the result of Comparison 1 as 100. The larger the value, the better the result is.
*2...O: irregular abrasion, Δ: A little bit, X:Have

Embodiment 4, Comparisons 9~10

Next, the effects of the rib's peripheral portion's rubber thickness on abrasion resistance and resistance to irregular abrasion were evaluated. The rubber composition of the central portion in Embodiment 4 as well a Comparisons 9 and 10 was of rubber type C, and the rubber composition of the peripheral portion was of rubber type D. The rubber thickness of the peripheral portion is as shown in Table 3. The results obtained are shown in Table 3.

Table 3

	Comparison 9	Embodiment 4	Comparison 10
Peripheral thickness (mm)	0.1	3	20
Abrasion resistance index *1	123	121	100
Resistance to irregular abrasion *2	X~Δ	O	O

*1...Displayed by expressing the abrasion resistance of the tire of Comparison 1 of Table 2 as 100. The larger the value, the better the result is.

*2...O: irregular abrasion, Δ: A little bit, X:Have

From Table 2 and Table 3, it is known that it is not possible to improve the abrasion resistance and resistance to irregular abrasion at the same time for the previous single treads or combination treads, but this invention allows these to be improved at the same time.

In this embodiment, a pneumatic tire having the basic rib pattern shown in Figure 3 was used, and the same test as that of the pneumatic tire having the basic block pattern shown in Figure 1 was carried out, and although the same results are obtainable, it can be confirmed that they are obtainable by enlarging the differences.

(Effectiveness of the Invention)

As explained above, for the pneumatic tire of this invention, it became possible to improve at the same time, the abrasion resistance and the resistance to irregular abrasion that previously could not be improved.

4. Brief Explanation of the Drawing(s)

Figure 1, Figure 2 and Figure 4 are respectively plan views each showing the tread portion of an example of the pneumatic tire of this invention.

Figure 3 and Figure 5 are respectively sectional views each showing the tread portion of an example of the pneumatic tire of this invention.

1...Block or rib
2...Central portion of block or rib
3...Peripheral portion of block or rib
4...Main groove
5...Edge portion

Patent Applicant: Bridgestone Corporation
Agent Attorney: Gyoshu Sugimura
Ditto Attorney: Kosaku Sugimura

Figure 1

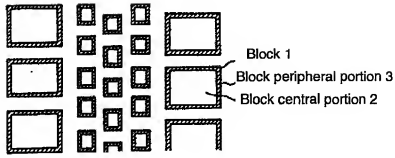

Figure 2

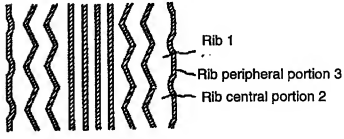

Figure 3

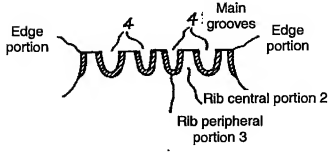

Figure 4

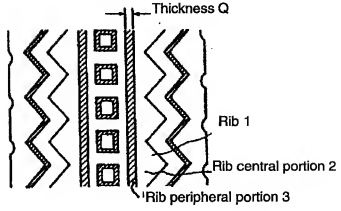

Figure 5